

***Agyrium* Fr., *Bryophagus* Nitschke ex Arnold and *Racodium* Fr., lichen genera previously unrecorded for Australia**

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Abstract

Agyrium rufum (Pers.) Fr. (Agyriaceae), *Bryophagus minutissima* (Vězda) D. Hawksw. (Gyalectaceae) and *Racodium rupestre* Pers. (*incertae sedis*) are recorded from Tasmania, representing the first reports of these lichen genera for Australia. Morphological and anatomical data, as well as information on the distribution and ecology of each species is presented.

Introduction

As a result of ongoing research on the Australian lichen flora, new records for the whole continent and especially for individual States continue to be reported; for example, see the ongoing series of papers in the journal *Australasian Lichenology*. However, most such records concern species, and new generic records are relatively infrequent. Studies on crustose lichens from Tasmania, and comparisons with authentic reference material, mainly from the Northern Hemisphere, have led to the identification of three genera previously unrecorded for Australia. Two, *Agyrium* Fr. and *Racodium* Fr., are cool temperate taxa and further demonstrate the strong floristic links that exist between Tasmania and the temperate, oceanic regions of the Northern Hemisphere. The third, *Bryophagus* Nitschke ex Arnold, has a more scattered distribution.

Methods

The work is based on the author's collections from Tasmania, held in the Tasmanian Herbarium (HO) and on comparative material in the Natural History Museum, London (BM), the Royal Botanic Garden, Edinburgh (E) and the Karl-Franzens-Universität, Graz (GZU). Observations and measurements of apothecial tissues and ascospores were made on hand-cut sections and squashes mounted in dilute KOH solution.

***Agyrium* Fr.**

The genus *Agyrium* is characterised by a poorly developed, immersed thallus, apothecial ascomata with a reduced annular exciple, richly branched paraphyses, eight-spored, *Trapelia*-type asci and simple, non-halonate, thin-walled, ellipsoid ascospores (Dennis 1981; Purvis & James 1992a; Lumbsch 1997). Although non-lichenised in the strictest sense, the mycelial hyphae are frequently associated with and penetrate green coccoid algae, especially in the vicinity of the apothecia, a condition described by Lumbsch (1997) as 'facultative parasitism'. Thus *Agyrium* superficially looks like a lichen, and its closest relatives are all lichens, including, in the Australian lichen flora, *Lithographa* Nyl., *Placopsis* (Nyl.) Lindsay, *Placynthiella* Elenkin, *Rimularia* Nyl., *Trapelia* M.Choisy, *Trapeliopsis* Hertel & G.Schneider and *Xylographa* (Fr.) Fr. These and some additional genera not known from Australia comprise the family Agyriaceae and are discussed extensively in the comprehensive paper of Lumbsch (1997).

Although several taxa have been included in *Agyrium* in the past, many of these have been transferred formally to unambiguously non-lichenised, unrelated genera. Only one species, *A. rufum* (Pers.) Fr. is currently recognised in the Northern Hemisphere (see Dennis 1981 and Purvis & James 1992a for descriptions) and occurs widely in Europe,

mainly on dead wood. This species is here recorded from Tasmania, representing the first record of the genus for Australasia. Two additional species of *Agyrium* are known from southern South America: *A. antarcticum* Rehm, reported from rotting *Nothofagus*, and *A. chilense* Speg., from rotting *Lobelia*.

Agyrium rufum (Pers.) Fr., *Systema Mycologicum* 2: 232 (1822); *Stictis rufa* Pers., *Observationes Mycologicae* 2: 74 (1799). Type: *n.v.*

Thallus immersed to absent, usually defined by pale, bleached patches of the substratum. Algal cells occasional, globose to broadly ellipsoid, 4–7 x 4–6 µm, mostly occurring around or beneath the apothecia. Apothecia scattered, pale orange to orange-red to red-brown, waxy or matt, convex, irregularly roundish, sometimes rather wrinkled or contorted, immarginate, 0.2–0.5 mm wide, 0.12–0.2 mm thick. Exciple (in section) very reduced, 20–40 µm thick, pale to deep orange-brown, K+ orange-red to red, sometimes fleetingly or soon becoming ± persistent pale yellow. Subhymenial tissues poorly differentiated, sometimes also with irregular patches pigmented as above. Hymenium 70–80 µm thick, intensely I+ blue, with an orange-brown pigmented epithelial layer c. 10 µm thick, sometimes uneven and extending deeper into the hymenium; reaction in K as above. Asci broadly clavate, 60–75 x 12–22 µm, of the typical *Trapelia*-type: outer wall amyloid; apex broadly rounded; tholus thick and well-developed, with a thin amyloid cap and weakly amyloid flanks, ± non-amyloid in the remainder; ascoplasm truncate to concave at the apex, without an ocular chamber (Fig. 1A; also see Rambold & Triebel 1990). Paraphyses richly branched, c. 1 µm thick, with somewhat swollen apices 1.5–2 µm thick. Ascospores 12–8 x (5–)6–8(–9) µm, broadly ellipsoid or egg-shaped, hyaline at first, becoming grey to deep brown when old, typically with one or several vacuoles.

Remarks: The above description is based on the Tasmanian specimens cited below. Their ascospores are somewhat larger than commonly seen in European material, although there is no major difference between the two populations. Brown spores are quite common in the Tasmanian material but were rarely seen in specimens from Europe. Similarly the pigmentation of apothecial tissues (and consequent K reaction) is more intense in Tasmanian specimens. These differences are likely to relate to the age of the apothecia and the degree of exposure of the microhabitat.

All Tasmanian specimens fall within the concept of *A. rufum* as accepted by Northern Hemisphere workers, but also display some critical morphological and ecological differences between them. One specimen is from alpine heathland where *Cetraria australiensis* W.A.Weber ex Kärn. and species of *Cladia* Nyl., *Cladonia* Hill ex P.Browne and *Cladina* Nyl. predominate. It grew on the dead, decorticated, bleached twigs of an unknown shrub, possibly a member of the Epacridaceae, associated with several other unusual crustose lichens including species of *Xylographa* (Fr.) Fr. and *Japewia* Tønsb. It has rather small, orange-red, waxy apothecia and is identical to European material, especially that which occurs on dead, bleached *Calluna* (Ericaceae) stems. Specimens from decorticated, bleached lignum of eucalypt logs in wet forests are virtually identical to European specimens from conifer lignum. The discovery of *Agyrium* in this habitat, especially as a pioneer in post-logging regeneration in forestry coupes, suggests the species may be quite widespread in Tasmania and has been previously overlooked. The specimen from cool temperate rainforest, growing on the bark of a very old, dry trunk of a mature *Nothofagus cunninghamii* tree, is unusual: the apothecia are a very deep reddish brown, and some of the younger apothecia have a scattered orange pruina; both young and old fruiting bodies are deeply pigmented within, and the K+ red reaction is very intense and persistent, especially in the excipulum; brown spores predominate in this specimen. These characters are rather extreme in the context of all the material studied, but until

more material is found, the specimen is included within *A. rufum*. It is rather similar to British material of *Lecidea grumosa* Leight. (= *A. rufum*) which is also from bark and is rather intensely pigmented within.

Authentic material of the South American species could not be located for comparison, but on the basis of descriptions both differ clearly from *A. rufum* on spore size alone. In *A. antarcticum* the spores are $10\text{--}12 \times 8\text{--}10\text{ }\mu\text{m}$ and clearly broader than those of *A. rufum* (Rehm 1899), whereas in *A. chilense* they are $10\text{--}11 \times 2\text{--}2.5\text{ }\mu\text{m}$ (Saccardo & Trotter 1913) and narrower.

Australian specimens examined: **Tasmania:** Arthur River, 250 m altitude, on *Nothofagus cunninghamii* in rainforest, 13.ii.1982, *G. Kantvilas* s.n. (HO); summit of Wild Dog Tier, $41^{\circ}47'S$ $146^{\circ}35'E$, 1390 m altitude, on dead wood in alpine heathland, 11.iii.2001, *G. Kantvilas* 375/01 (BM, HO); track to Mother Cummings Peak, $41^{\circ}41'S$ $146^{\circ}32'E$, 1150 m altitude, on decorticated eucalypt wood in subalpine scrub, 3.iii.2002, *G. Kantvilas* 147/02 (HO); west of Tahune Bridge, 'Small Coupe', $43^{\circ}06'S$ $146^{\circ}42'E$, 100 m altitude, on decorticated bleached eucalypt log in regenerating logging coupe, 19.ii.2002, *G. Kantvilas* 171/02 (GZU, HO).

Selected comparative material examined: **United Kingdom:** West Ross (V.C. 105), Kinlochewe, Beinn Eighe NNR, Coille na Glas-leitir, c. 100 m altitude, on lignum of fallen, decorticate *Pinus*, 12.iv.2001, *B.J. and A.M. Coppins* s.n. (HO); East Ross (V.C. 106), Amat Forest, on *Betula* lignum, 28.v.1975, *B.J. Coppins* 2224 & *F. Rose* (E); Perthshire, Tulloch, near Killiecrankie, on decorticate *Calluna* twigs in burn-out, 24.vi.1972, *R. Watling* (E); Easternness (V.C. 96), Abernathy Forest, on decorticated branch of *Pinus*, 1250 feet altitude, 24.v.1976, *B.J. Coppins* 3162 and *L. Tibell* (E); South Hants (V.C. 11), New Forest, Brockenhurst Woods, Bakers Copse, on decorticated *Fraxinus*, 31.i.1982, *P.W. James* (BM). **Ireland:** Galway, Ballynahinch, on pine bark, ii.1877, *Larbalestier* (BM). **Austria:** Steiermark, Rücken der Aflenzer Staritzen NE über Aflenzen, 1700–1800 m altitude,

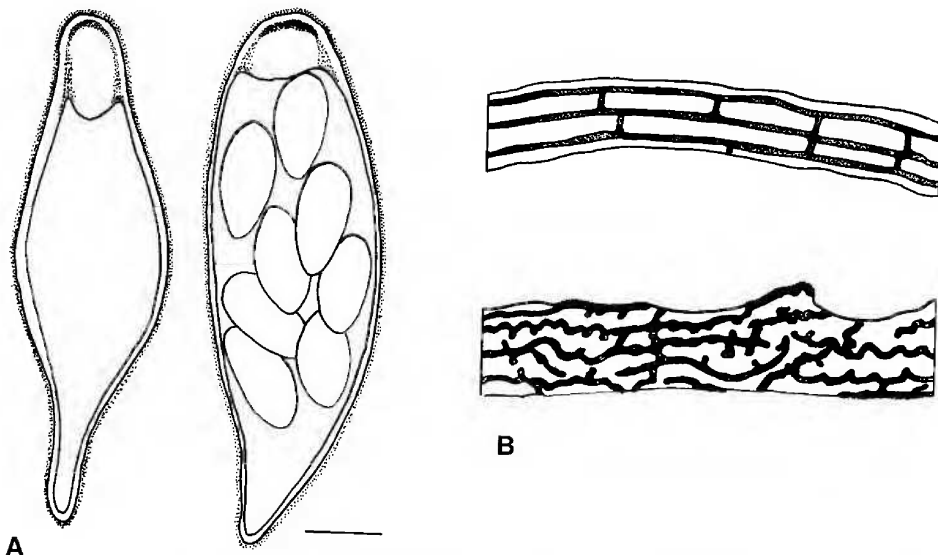


Figure 1. A: Asci and ascospores of *Agyrium rufum* with amyloid parts stippled; B: portion of thallus filaments of *Racodium rupestre* (above) and *Cystocoleus ebeneus* (below), showing the different arrangement of the dark fungal hyphae on filaments of the alga *Trentepohlia*. Scales: A= $10\text{ }\mu\text{m}$; B= $20\text{ }\mu\text{m}$.

2.ix.1984, *I. Brodo and J. Poelt* (GZU); Salzburg, Pinzgau, Nationalpark Hohe Tauern, Wildgerlostal, zwischen Gasthaus Finkau (1420 m) und Trisslalm (1583 m), 23.vii.1992, *C. Scheuer* (GZU).

***Bryophagus* Nitschke ex Arnold**

Bryophagus is a genus of three species currently included in the family Gyalectaceae: *B. gloeocapsa* Nitschke ex Arnold from Europe, *B. similis* (Vězda) Kalb, from tropical America, and *B. minutissima* (Vězda) D. Hawksw. from New Guinea. This last species is here recorded from Tasmania, representing the first report of the genus for Australia. Accounts of the genus are provided by Vězda (1966, 1973) and Purvis and James (1992b). In the past, nomenclatural problems caused all these species to be included in the genus *Gloeoctea* Lettau, but this name is now regarded as a synonym of *Bryophagus* (Hawksworth *et al.* 1980).

Bryophagus is superficially similar to several other genera of tiny, inconspicuous crustose lichens, especially to *Gyalecta* Ach. and *Absconditella* Vězda (neither presently known in Tasmania), and *Gyalidea* Lettau (represented in Tasmania by *G. hyalinescens* (Nyl.) Vězda). Taxa in these genera typically have a crustose, sometimes \pm gelatinous thallus, small to minute, gyalectoid, pale-coloured to translucent apothecia, elongate, clavate asci typically with only a slightly thickened apex, simple paraphyses and hyaline, frequently 3-septate ascospores. Separation of these genera is not straightforward. In *Gyalecta*, the photobiont is *Trentepohlia* whereas the other genera have a coccoid photobiont; in the case of *Bryophagus*, the photobiont is the distinctive *Gloeocystis* in which the small, \pm globose or ellipsoid cells are grouped within a thick gelatinous sheath. Although having asci with an amyloid wall after pretreatment in KOH, the asci of *Absconditella* have a rather prominent, thickened tholus whereas those of *Bryophagus* are only very slightly thickened. *Gyalidea* and *Gyalecta* have asci rather similar to *Bryophagus* but these are entirely non-amyloid. In addition, the ascospores of *Gyalidea* have a thin gelatinous perispore whereas those of *Bryophagus* do not.

Bryophagus minutissima (Vězda) D. Hawksw., in D.E. Shaw, *Microorganisms in Papua New Guinea*: 248 (1984); *Gloeoctea minutissima* Vězda, *Folia Geobot. Phytotax.* 8: 312 (1973). Type: Papua New Guinea: eastern Highlands, Bismarck Ranges, Mt Wilhelm, Imbuku Ridge above Lake Auende, 3450 m, 26.vi.1968, W.A. Weber & D. McVean (holotype COLO L48422b, *n.v.*).

Thallus not visible, evident only as necrotic patches over the bryophyte substratum. Photobiont cells globose, 2–3 μ , with a thick gelatinous sheath to c. 5 μ thick. Apothecia scattered over or slightly embedded in the substratum, lecideine, 0.6–1.3 mm wide, hyaline, gyalectoid, with a markedly and persistently concave disc, partly obscured by an incurved, cup-shaped proper margin when young, becoming gaping and excavate when old. Excipulum hyaline, c. 20 μ thick. Hymenium 30–40 μ thick, hyaline, I+ faint yellow-brown before pre-treatment with KOH, persistently I+ pale blue after pre-treatment. Asci cylindrical-clavate, 26–35 \times 4–4.5 μ , 8-spored; apex slightly thickened, I-; outer wall I+ blue, somewhat thicker at the apex of the ascus. Paraphyses simple, mostly \pm straight, 0.5–0.8 μ thick, with apices very slightly thickened. Ascospores bacilliform, 3-septate, 8–13 \times 1 μ . Pycnidia unknown.

Remarks: The Tasmanian specimen is very sparingly fertile and with most apothecia over-mature and with eroded hymenia. Hence, the anatomical data given above are based mainly on the type description by Vězda (1973), supplemented where possible with observations from the Tasmanian material. In Tasmania, this species occurs over a mat of

hepatics on disturbed, sandy soil in an abandoned copper-mining area, a habitat also favoured by the Northern Hemisphere species, *B. gloeocapsa*. *Bryophagus minutissima* is extremely inconspicuous and easily overlooked, especially as the thallus is almost absent and the apothecia vary from small to minute, are \pm translucent and very difficult to detect even with a lens. Indeed the best clue to its presence is provided by the death in small circular patches of its bryophyte hosts.

Bryophagus minutissima is well separated from the other species of the genus by its markedly smaller apothecia and ascospores. In *B. gloeocapsa*, the apothecia are 0.2–0.5 mm wide, rather immersed in a glossy, gelatinous thallus, and the spores are $20\text{--}30 \times 1.5\text{--}2 \mu\text{m}$. In *B. similis*, the apothecia are 0.3–0.5 mm wide and the spores are $12\text{--}15 \times 2.5\text{--}3 \mu\text{m}$.

Australian specimen examined: Tasmania: Queenstown, opposite old Mt Lyell Mine Office, $42^{\circ}05'S$ $145^{\circ}33'E$, on hepatics over gravelly bank colonised by bryophytes, 200 m altitude, 6.ii.1984, *G. Kantvilas* & *P.W. James* 191/84 (BM, herb. Vězda, HO).

Racodium Fr.

The genus *Racodium* is an obligately sterile genus of filamentous lichens. In the past, it has also included non-lichenised representatives but, as discussed in detail by Hawksworth (1970), it is correctly based on the lichenised hyphomycete *R. rupestre* Pers. and should be considered monotypic. This species is known from Europe and North America and has recently also been recorded from New Zealand (Wirth 1997).

Racodium rupestre Pers., *Tent. Disp. Meth. Fung.*: 76 (1797). Type: *n.v.*

Thallus filamentous, forming irregularly spreading, black, felt-like patches on the sheltered faces of rocks in cool, damp environments; filaments loosely entangled, $10\text{--}20 \mu\text{m}$ wide. Photobiont *Trentepohlia*, forming long chains of cells. Fungal hyphae c. $1 \mu\text{m}$ thick, arranged in a parallel manner along the length of the filaments and forming a rectangular, net-like pattern. Apothecia and pycnidia unknown.

Remarks: The Tasmanian specimens accord completely with authentic material from Europe (for description see Dalby 1992). *Racodium rupestre* is superficially very similar to *Cystocoleus ebeneus* (Huds.) Hariot, a lichen which occurs in identical habitats but appears to be far more common and widespread. The two taxa can only be separated by high-power microscopy. *Cystocoleus ebeneus* differs by having fungal hyphae which are of noticeably uneven thickness, arranged irregularly over the surface of the algal filaments (see Fig 1B and Purvis *et al.* 1992).

Racodium rupestre is uncommon in Tasmania although it may well have been overlooked. In contrast, it is significant that the similar *C. ebeneus* is very common and has been very frequently collected. The sheltered, shaded, often overhanging faces of large boulders in generally moister vegetation types are the typical habitat for both species. Both taxa are typically found at higher elevations in open woodland and heathland, although *C. ebeneus* is also known to occur in the lowlands, even on coastal rocks.

Australian specimens examined: Tasmania: track to Mother Cummings Peak, $41^{\circ}41'S$ $146^{\circ}32'E$, on sheltered faces of large dolerite boulders at scrubby rainforest edge, 1000 m altitude, 3.iii.2002, *G. Kantvilas* 149/02 (HO); Mt Sprent, $42^{\circ}48'S$ $145^{\circ}58'E$, on Precambrian rocks in alpine heathland, 1050 m altitude, 17.ii.1987, *G. Kantvilas s.n.* (HO); Mt Arrowsmith, $42^{\circ}12'S$ $146^{\circ}05'E$, on rocks, 960 m altitude, 14.xi.1964, *G.C. Bratt* 1778 (HO).

Comparative material examined: **Sweden:** Härjedalen Province, southern slope of Mt Gruvvålen, 62°43'N 12°25'E, on exposed rock in the upper part of the subalpine region, c. 900 m altitude, 1.ix.1970, R. Santesson 22567 (*Lichenes Selecti Exsiccati Upsaliensis* 45) (GZU).

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